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ABSTRACT

Three empirical dimensions of curriculum structure are presented in this study of the differences among subject areas in student perception of cognitive and affective classroom processes. Class Activities Questionnaire items were used to obtain data from 121 Illinois classes in science, mathematics, social studies, and language arts for grades 6-12. Discriminant analysis reveals the dimensions to be (1) interpreting versus analyzing in contrast to language arts versus mathematics; (2) synthesizing versus knowing in contrast to language arts and mathematics versus social studies and science; and (3) exploring versus evaluating in contrast to science versus social studies. It appears that these school subjects place distinctly different demands on students. (Author)

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CURRICULUM STRUCTURE AS REFLECTED IN PERCEIVED COGNITIVE AND AFFECTIVE PROCESSES[1]

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Since ancient times, the field of curriculum has been guided *a priori*, hypothetico-deductive theories of the nature of knowledge and has been divided into subject matter on logical grounds. The Chinese system divided knowledge into three categories -- man-to-thing, man-to-man, and man-to-spirit -- which correspond to our classifications of natural sciences, social sciences, and humanities (Lux and Ray, 1970). Aristotle's distinctions between the theoretical, practical, and productive disciplines were anticipated in Plato and can be traced into the writings of Alfred North Whitehead, William James, and Jerome Bruner (Lowy, Blokesberg, and Walberg, 1971). Auguste Comte too, has had an enormous effect on curriculum structure, proposing a scheme widely used in place of Aristotle's, involving a hierarchy with mathematics at the highest level followed by physics, chemistry, biology, and the social sciences. From such logical distinctions, practical concepts such as concreteness -- abstractness, specificity -- generality, immediacy -- remoteness, and past-present-future have been used to study the curriculum components and to develop new instructional materials. In the last decade, however, psychologists have begun empirical studies of the curriculum from student perceptions

EA 004 155

of courses in different subject matter areas. The present paper reviews this recent work, presents three empirical dimensions of curriculum structure in terms of a taxonomy of cognitive educational objectives and affective classroom processes, and relates the dimensions to other conceptualizations of the curriculum.

Several studies have assessed student perceptions of a single subject area (Wick and Yager, 1966; Vitrogan, 1969; Granger and Yager, 1970; Reinart, 1970; Roberts, 1970; Ehman, 1970). Although a few attempt a more detailed analysis of the subject area, (Moore and Sutman, 1970), most rely on a few measures of affective feeling toward the subject. Such studies, of course, do not identify the distinguishing features of the several subject areas.

Somewhat more useful in this regard are studies which directly compare one subject area to another. In an analysis of variance design Trickett and Moos (1970), for example, found average "Satisfaction" scores high in English classes, medium in Government and Biology, and lowest in Mathematics classes. Snow and Cohen (1968) found significant differences among college students' ratings of prestige of various subject areas; the ratings were related to the respondents' major field of study. These investigators used single rather than multiple dependent measures.

In an early attempt to identify variables that distinguish among major fields of study, Thistlethwaite (1962) used multiple measures of student perception as dependent variables. He used 10 faculty press scales and 10 student press (peer influence) scales of the Inventory of College Characteristics. Using analysis of variance and covariance techniques he found that major field classification accounted for more than 20% of the total variance of scores on the faculty Humanism, Scientism, and Vocationalism scales, but less than 5% of the variance

on the student press scales.

Among Physical Sciences and Mathematics students there was a strong faculty press for Scientism, Compliance, and Vocationalism, but weak faculty press for Humanism and Independence. Similarly the student press was strong for Scientism and weak for Estheticism and Reflectiveness. The Humanities and Social Studies students perceived strong faculty press for Humanism, Independence, and Enthusiasm but weak faculty press for Scientism, Compliance and Vocationalism; the student press was strong for Estheticism and Reflectiveness.

In a later study of college courses Astin (1965) suggested that the student perceptions of classroom environment were a useful basis for classifying different subject fields empirically. A factor analysis of a student questionnaire produced three factors. Factor I was "Foreign Language versus Social Science", with Foreign Language characterized by enthusiastic instructors who knew their students by name while the Social Sciences were characterized by little classroom discussion, little homework, and arguing with the instructor. Factor II was "Natural Science versus English and Fine Arts", with the former high on students not speaking in class, and the latter high on class discussion, humor and diverse opinions. The third factor was "Business versus History Classes", with more testing emphasis, less research emphasis, and duller instructors in Business.

In a Semantic Differential, factor analytic study of suburban sixth through ninth grade classes, Yamamoto, Thomas, and Karns (1969) found that Mathematics and Science classes rated high on a factor labelled "Vigor" (alive-large-strong-fast) while Social Sciences and Language Arts rated high on a "Certainty" factor (safe-easy-usual-familiar). In the sixth and seventh grade, Language Arts and Social

Studies scored higher on the "Vigor" factor but in the eighth and ninth grades Math and Science were relatively preferred. However, all factors declined absolutely with increased grade level, consistent with Neale and Proshek's finding (1967) that attitudes toward school are less favorable in ascending grades.

The most recent study is that of Anderson (1971, in press) which compared the learning environment of Science, Mathematics, French, and Humanities (including History) classes in eight high schools. The dependent variables were 15 scales on the Learning Environment Inventory which emphasize the social environment of the class. A multivariate analysis of covariance related individual scales to the subject matter levels, with class size, sex of students, and IQ as covariates; and discriminant analysis was also employed.

Anderson found three significant discriminant functions which he did not attempt to name. On the first dimension Mathematics classes were separated from the other subject areas and were characterized as being high in intraclass Friction ("Certain students are considered uncooperative.") and high in Favoritism ("Only the good students are given special projects."). Mathematics classes were also low on Formality ("Students are asked to follow a complicated set of rules."). The second discriminant function separates Science classes at one end and Humanities (English plus History) classes at the other; this dimension is characterized at the Science end by high Disorganization ("This class is disorganized.") and high Satisfaction ("Students are well-satisfied with the work of the class."). The Humanities end is high in Diversity ("This class divides its efforts among several purposes") and high in Apathy ("Members of the class don't care what the class does."). The third dimension separates French from the other subjects with the French end being characterized

as high on Goal Direction ("The objectives of class are specific.") and low on Satisfaction ("Students are well-satisfied with the work of the class.").

Differences in the dependent measures characterizing subject areas, as well as different ways of grouping subject areas for analysis, makes summary of the foregoing studies difficult. What is clear from the review of comparative studies is that whether the dependent variables are single or multiple, cognitive or affective, or the analysis univariate or multivariate, students do perceive subject matter areas differently. The purpose of the present study is to examine the differences among four subject areas on student perception of cognitive and affective processes occurring in those classes. The results are considered in terms of the curriculum structure of these content areas. No attempt is made to separate subject from instructional method.

METHOD

Sample

Data were collected in 1969-70 from 121 classes in 69 schools in Illinois as part of a statewide evaluation study. Classes ranged from grade 6 to 12 and represented the four subject areas of Science, Mathematics, Social Studies, and Language Arts, as shown in Table 1.

Insert Table 1 about here

One carefully drawn group of 52 classes were "gifted" classes representative of all programs in these subject areas supported by the state. A group of 69 "average" classes were drawn as a comparison group with care not to include any below average classes. The "average" sample was drawn from three Chicago suburban districts--in the main, white,

middle-class and socio-economically average--and is not necessarily representative of "average" classes in general. See Table 1 for a description of the sample by subject and grade level.

Instrument

Twenty-three items from the Class Activities Questionnaire were used to obtain the students' perception of prevailing patterns of instructional emphasis. Students were asked to agree or disagree on a four-point scale to statements describing general kinds of activities which characterize their class. These activities imply either one of seven levels of thinking derived from Bloom's Taxonomy (Bloom, 1956), or one of nine affective conditions stressed in class. A description of the development and analysis of this instrument and evidence for reliability are presented in Steele, House, and Kerins (1971).

Procedure

For purposes of this analysis the class means for each item on the Class Activities Questionnaire were used rather than the usual consensus scoring procedure. Since this was an exploratory study, it was felt that no theoretical framework should be imposed on the data. In order to obtain a more valid assessment of the effects of course content on classroom climate, several additional variables were controlled. Giftedness, class size, grade level, their quadratics, and interactions were included as eight covariates in the analysis.

Statistical Analysis

The resulting data were subjected to a multivariate and univariate analysis of covariance and variance with discriminant functions. To introduce as much statistical control as possible, the several possibly contaminating effects were removed from the criteria by covariance adjustments before testing the differences among the

four subject matter areas. The covariates included the following variables:

Linear

Grade Level (L)

Class Size (S)

Class Type (T; coded "1" if designated gifted, "0" otherwise)

Quadratic

L^2

S^2

Interactions

L x S

L x T

S x T

Two covariance analyses were computed: one with only linear covariates, the other with all covariates. The significance, magnitude, and direction of the differences among subject matter areas were stable whether no covariates, linear only, or all covariates were included in the analyses of variance.

Insert Table 2 about here

As can be seen in Table 2, the magnitude and significance of the discriminant variates are very nearly the same for each of the three models: the first discriminant function accounts for between 69 and 75 percent of the variance; the second discriminant function between 14 and 17 percent; and the third, for between 11 and 13 percent; the Chi-Square approximations to Wilk's lambda (Bock, 1966) are also quite close. These figures suggest that the three curriculum effects (discriminant functions for subject matter differences) are strong enough to be highly significant (chance probability less than .001)

with elaborate, simple, or no covariance controls. Thus we turn to the substantive findings in which for simplicity, and to avoid redundancy we have presented only the results for the "full covariance" analysis.

RESULTS

The positions of each level of content on each discriminant function are shown numerically and graphically in Figure 1. On the first discriminant function (D_1), the greatest contrast is

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Insert Figure 1 about here

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between Language Arts and Mathematics. The second discriminant function (D_2) maximally separates Language Arts and Mathematics on one hand from Science and Social Studies on the other. The third discriminant function (D_3) indicates greatest separation between Science and Social Studies. (It should be remembered that the three functions are independent of one another.)

The next question is "What do the three discriminant space dimensions mean?" This was determined by relating the individual dependent variables to each dimension. There are three ways of representing this relationship: 1) by comparing least square estimates of individual variables on each function (Anderson, 1971); 2) by comparing the discriminant coefficients of each variable for each function (Tatsuoka, 1970); 3) or by comparing the correlations between the dependent variable and the discriminant function, called here the discriminant "loadings" (Anderson, Walberg, and Welch, 1969). Since interpretation of discriminant analysis is in dispute and unsettled, we chose to use the statistic that yielded the most meaningful interpretation. This proved to be the loadings.

To name each function and interpret its meaning, we examined the loadings. Table 3 shows the items which have significant loadings with the first discriminant function (D_1), which we have named "Interpreting versus Analyzing." This contrast fits well the

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Insert Table 3 about here

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common sense notions of Language Arts versus Mathematics, the two subjects most strongly contrasted on this dimension. D_1 also represents a contrast between two well-established psychometric factors--Linguistic versus Quantitative. The variables associated with the Language Arts side of the dimension have to do with the cognitive objectives: interpretation (Items 16 and 6), evaluation (Item 20), synthesis (Item 23), and translation (Item 9). Affective processes include student independence (Item 14) and participation in discussion (Item 5). Associated with the Mathematics side of D_1 are variables dealing with analysis (Items 12 and 7) and memory (Items 1 and 10) and the affective conditions of test/grade stress (Items 8 and 22), little humor (Item 25), and little discussion (Item 15). While the major operation seems to be "Interpreting versus Analysing," another way of characterizing this discriminant function might be the contrast of "Loose versus Precise" or (in light of the affective components) "Open versus Controlled."

Loadings on the second discriminant function (D_2) are shown in Table 4. D_2 has been named "Synthesizing versus Knowing." It repre-

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Insert Table 4 about here

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sents a contrast between the two tool subjects of Language Arts and Mathematics on one side and the two observational subjects of Science and Social Studies on the other. The variables associated with Math

and Language Arts include the cognitive objectives: synthesis (Items 23 and 11), translation (Itsm 9), and application (Item 3). Associated with science and Social Studies are the cognitive activities of summarizing (Item 21), memorizing (Items 1 and 10) and evaluating (Item 20.) Another way of looking at the activities involved in D_2 might lead one to describe them as "Doing It versus Watching It" or "Work to Produce versus Work to Behold." At another level the dimension might be related to Schwab's (1964) distinctions of "Syntax versus Substance." At this point, however, it seems unwise to go much beyond the actual activities described in the items themselves.

Loadings on the third discriminant function (D_3) are shown in Table 5. D_3 has been named "Exploring versus Evaluating." It repre-

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Insert Table 5 about here

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sents a contrast between Science and Social Studies. The variables associated with the Science side of this function include independent exploration (Item 14), learning and memorizing (Items 1, 8, and 10), interpreting (Item 6), and synthesizing (Item 23). Associated with the Social Studies side of D_3 are variables dealing with evaluating (Items 2 and 20) and little humor (Item 25). This discriminant function is more difficult to interpret due to the diverse activities associated with Science. One way of characterizing this function might be the contrast of seeking and acquiring information in the case of Science versus reacting to and weighing information in the case of Social Studies. Succintly stated, a contrast of "What? versus So What?"

IMPLICATIONS

What are the implications of these data? First, they suggest that different subject areas as currently taught in the schools do indeed place distinctively different cognitive demands upon the students. Students in Math classes are subjected to a different classroom press and receive a quite different education than those in primarily Language Arts or Social Science classes. It is difficult to determine whether these differences lie within the logic of the subject areas themselves or simply in the way they are being taught.

Second, perhaps a rethinking of classroom processes and intellectual tasks is in order. In a recent provocative article on mental abilities, Rohwer (1971) classified intellectual tasks along two dimensions which are similar to the first two dimensions of classroom press identified here. His first dimension, Imaginative Conceptual Tasks versus Formal Conceptual Tasks, seems similar to what we have labelled here "Interpreting versus Analyzing." Imaginative Conceptual Tasks depart from conventional rules and organize material with self-generated images, similar to the Interpretation tasks here associated with Language Arts. Formal Conceptual activities are characterized by a set of formal rules that can be exhaustively described and mastered, much like the Analysis dimension here associated with Mathematics.

Rohwer's second dimension contrasts Acquiring and Producing Information versus Recalling and Applying Information. This dimension is similar to the "Synthesizing versus Knowing" contrast in this study. The observationsl subjects of Social Studies and Science, which call for mastering and applying bodies of concepts and facts, are highest on Recall and Apply, while the "tool" subjects of Language Arts and Math, each focusing on mastery of a "grammar" more than on a body of

facts, are highest on the Acquire and Produce dimension.

The parallel between Rohwer's concepts and our first two discriminant functions are intriguing. A reconceptualization of intellectual tasks is suggested. At present one can only conjecture the implications. For example, "creativity" might be seen as at least two-dimensional. Producing an original painting may require going beyond accepted rules (Imaginative-Interpretation) but at the same time requires the mastery of the "grammar" or "syntax" of painting. Such an activity would lie in the region between Interpreting and Synthesizing in Figure 1 and involve the generation of images from personal experience and/or the inventive manipulation of the syntax. "Divergent thinking," in contrast to "creativity," may lie closer to the Imaginative dimension (Interpretation in Figure 1) and require less manipulation of the basic "grammar" of the subject.

It is also possible to be "creative" in a subject like Mathematics by learning the basic "grammar" of the subject, i. e., the formal rules, and generating new forms of these rules along the synthesis dimension. Thus one could produce new forms without being divergent. (It should be noted that Figure 1 is plotted relative to Science. The figure does <u>not</u> necessarily indicate that Mathematics is taught as a synthesizing subject, only that it is more so than Science.) We might expect engineering studies to lie more in the region between Knowing and Analyzing in Figure 1. It is no surprise that Social Studies is seen as a body of facts that requires interpretation through the use of self-generated images drawn from one's own experience.

Such descriptions of activities related to the four quadrants produced by the first two discriminant functions are, of course, speculative. However, if the two dimensions relating the subject matter

to cognitive processes are replicated in subsequent work, it would further imply an intriguing parallel to Rohwer's analytic dimensions hypothesized from mental abilities research. It might then be possible to relate specific components of the classroom press to the differential development of components of the intellect.

[1] We are indebted to Shirley Daniloff, Center for Instructional Research and Curriculum Evaluation, for assistance in reviewing the literature. Our thanks to Mark Bargen of the Office of Evaluation Research at the Chicago Circle Campus for programming the Statistical analysis. We thank James Robinson, Barak Rosenshine, Robert Stake, and James Wardrop for comments on an early draft of the paper.

TABLE 1

Description of the Sample

Subject Areas	Mean Class Size	Number at Each Grade Level 6	7	8	9	10	11	12	Number of Gifted Classes	Total No. of Classes
SCIENCE	22.8	2	2	3	0	13	0	1	7	21
MATHEMATICS	23.0	2	0	1	8	6	4	3	7	24
SOCIAL STUDIES	25.3	3	7	5	0	2	7	0	13	25
LANGUAGE ARTS	22.8	8	5	9	5	4	14	6	25	51
TOTALS	23.4	16	14	18	13	25	25	10	52	121

TABLE 2

Multivariate F for Variance of Twenty-Five Criteria Accounted For By Covariates and Percent of Variance Accounted For by Discriminant Functions for Three Models

	No Covariates	Linear Covariates	Linear and Quadratic Covariates
F-ratio	5.68***	5.85***	5.45***

Discriminant Function	Discriminant Variance (%)	Chi Square	df	Discriminant Variance (%)	Chi Square	df	Discriminant Variance (%)	Chi Square	df
1	74.60	275.32***	69	71.70	278.79***	69	69.12	262.78***	69
2	14.07	107.15***	44	17.04	115.76***	44	17.50	114.07***	44
3	11.33	49.02***	21	11.26	48.77***	21	13.38	51.24***	21

***Significance beyond the .001 level

TABLE 3

CAQ Variables Loading on the First Discriminant Function (D_1)

Item Number		Loading
12	Using logic and reasoning processes to think through complicated problems (and prove the answer) is a major activity.	.542**
8	The student's job is to know the one best answer to each problem.	.396**
1	Remembering or recognizing information is the student's main job.	.350**
25	There is very little joking or laughing in this class.	.321**
7	Great importance is placed on logical reasoning and analysis.	.298**
22	There is a great concern for grades in this class.	.290**
15	There is little opportunity for student participation in discussions.	.265**
10	Great emphasis is placed on memorizing.	.189*
5	The class actively participates in discussions.	-.281**
6	Students are expected to go beyond the information given to see what is implied.	-.331**
14	Students are encouraged to independently explore and begin new activities.	-.362**
9	Restating ideas in your own words is a central concern.	-.552**
23	Inventing, designing, composing, and creating are major activities.	-.557**
20	The student's major job is to make judgments about the value of issues and ideas.	-.590**
16	Students are expected to read between the lines to find trends and consequences in what is presented.	-.606**

* and ** Significance at the .05 and .01 level respectively.

TABLE 4

CAQ Variables Loading on the Second Discriminant Function (D_2)

Item Number		Loading
23	Inventing, designing, composing, and creating are major activities.	.435**
11	Students are urged to build onto what they have learned to produce something brand-new.	.328**
9	Restating ideas in your own words is a central concern.	.221**
3	Students actively put methods and ideas to use in new situations.	.210*
10	Great emphasis is placed on memorizing.	-.213*
20	The student's major job is to make judgments about the value of issues and ideas.	-.237**
1	Remembering or recognizing information is the student's main job.	-.328**
21	Great importance is placed on explaining and summarizing what is presented.	-.405**

* and ** Significance at the .05 and .01 level respectively.

TABLE 5

Loadings on the Third Discriminant Function (D_3)

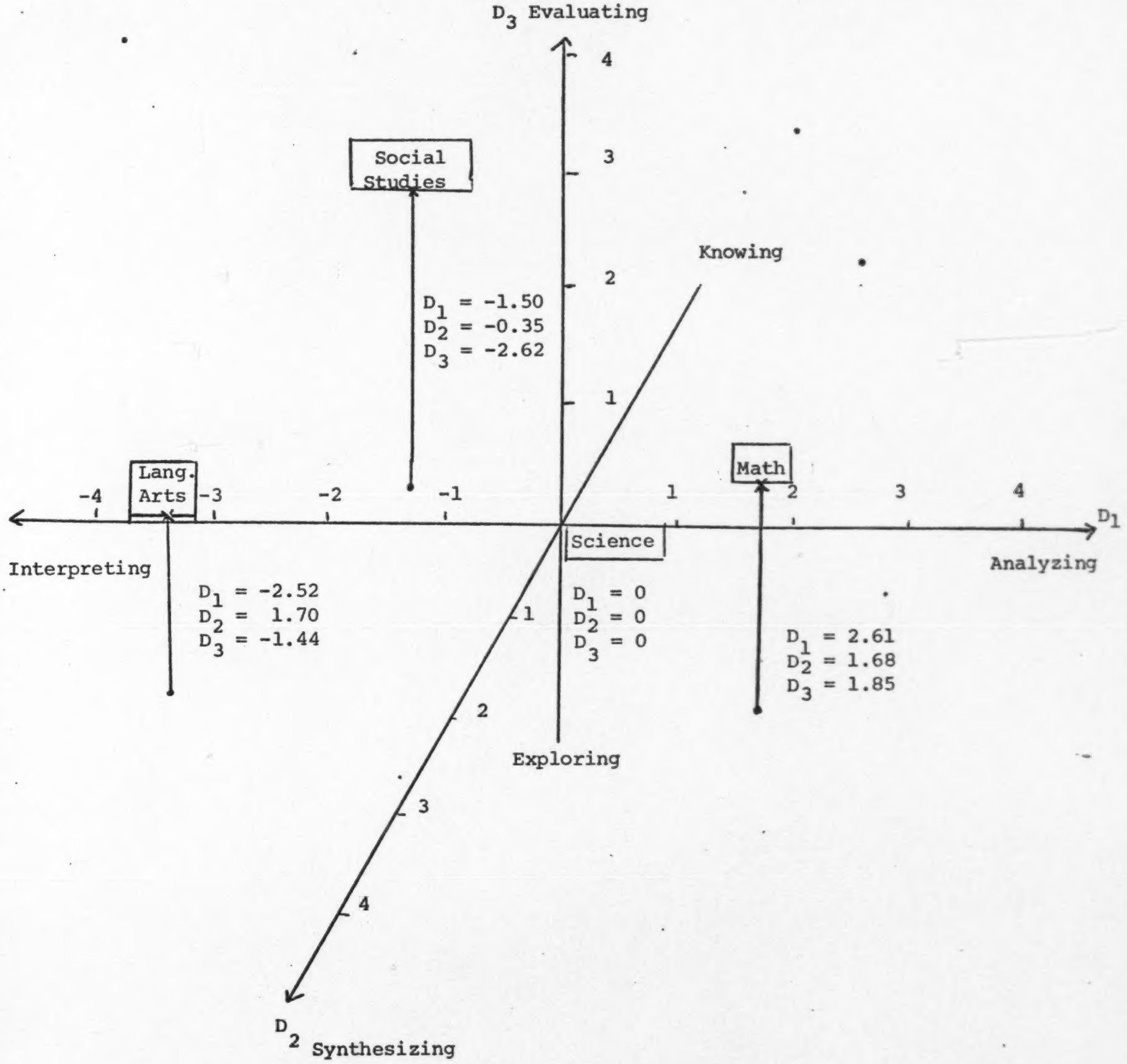
Item Number		Loading
14	Students are encouraged to independently explore and begin new activities.	.434**
10	Great emphasis is placed on memorizing.	.340**
1	Remembering or recognizing information is the student's main job.	.308**
6	Students are expected to go beyond the information given to see what is implied.	.255**
23	Inventing, designing, and composing and creating are major activities.	.248**
8	The student's job is to know the one best answer to each problem.	.234**
25	There is very little joking or laughing in this class.	-.220*
20	The student's major job is to make judgments about the value of issues and ideas.	-.241**
2	A central activity is to make judgments of good/bad, right/wrong, and explain why.	-.292**

* and ** Significance at the .05 and .01 level respectively.

19

FIGURE 1

Plots of Course Content Groups in Discriminant Space (Full Covariate Model)



20

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